Claims

1. A method for testing a control system (2) in a vessel (4), in which said control system (2) comprises control and monitoring of said vessel (4) with control signals (13) to one or more actuators (3), said method comprising the following sequential steps:

* acquisition in real time of sensor signals (7) to said control system (2) from one or more sensors (8) over a first sensor signal line (12) to said control system (2);
* acquisition of command signals (9) to said control system (2) from a command input device (10) over a second signal line or command signal line (11) to said control system (2);
* computation in a control algorithm (31) in said control system (2) on basis of one or more of said sensor signals (7) and said command signals (9), and sending of said control signals (13) over a third signal line (14) to said actuators (3)

characterised by

* disconnection of one or more of said sensor signals (7) from one or more of said sensors (8) or of said command signals (9) from said control input devices (10), so that the selected sensor signals (7) or command signals (9) do not flow to said control system (2), and replacement of one or more of said disconnected sensor signals (7) or said command signals (9), with corresponding simulated sensor signals (7') or simulated command signals (9') that are generated in a remote test laboratory 40) with respect to said vessel (4) and are sent over a communication line (6) over one or more of said signal lines (12, 14) to said control system (2);
* continued computation in said control system (2) on basis of said real and/or said simulated sensor signals (7a or 7a', 7b or 7b', 7c or 7c', ..) or said real and/or said command signals (9a or 9a', 9b or 9b' , 9c or 9c', ..) of control signals (13'), and
* sending of said control signals (13') over said communication line (6) to said remote test laboratory (40).

2. The method of claim 1, comprising simulation in a simulator (30) in said test laboratory (40) by means of an algorithm (32) of a new dynamic state of a vessel model (4') on basis of said control signals (13').

3. The method of claim 1, in which said sensor signals (7) comprise one or more of the following sensor parameters from said sensors (8):
- a position (7a) of said vessel from position sensors (8a), such as GPS receivers (8a); hydroacoustic position sensors (8h), integrating acceleration sensors, etc.;
- a course (7b) from course sensors (8b), e.g. a gyrocompass or some other compass;
- a velocity (7c) from a velocity sensor (8c) or an integrating acceleration sensor;
- a wind speed (7d) and a wind direction (7e) from an anemometer (8d, 8e);
- a roll angle (7f) from a roll angle sensor (8f);
- a pitch angle (7g) from a pitch angle sensor (8g).

4. The method of claim 1, in which said control signals (13) comprise signals (13a, 13b, 13c) in the form of shaft speed (13a, 13b) for one or more propellers (16) or thrusters (17), and angles (13c) for rudder (18) or thrusters (17) and possible other control devices to achieve one or more of desired position (9a), course (9b), velocity (9c).

5. The method of claim 1, in which said propellers (16) comprise one or more propellers (16a, 16b, 16c, ..).

6. The method of claim 1, in which said control devices (18) comprise one or more rudders (18a, 18b).

7. The method of claim 1, in which said control devices (18) comprise one or more thrusters (17)

8. The method of claim 1, in which said command input device (10) comprises at least one position specification device (10a), a wheel (10b), a velocity specification device (10c), or a device for specification of desired roll angle, pitch angle, heave compensation, etc. 10x) that gives a command signal for one or more of desired position (9a), desired course (9b), and desired velocity (9c) or some other desired variable (9x), e.g. desired roll angle, desired pitch angle, desired heave compensation, etc.

9. The method of claim 1, in which said remote test laboratory (40) is used to verify that said control signals (13, 13') from said control system (2) on basis of said simulated sensor signals (7') and said simulated command signals (9') in a test, and possibly remaining real sensor signals (7) and remaining real command signals (9), are such that said control signals (13, 13') will lead to a desired state of said vessel (4), and where said control system (2) is certified on basis of this.

10. The method of claim 1, in which the computation in said control algorithm (31) of said control system (2) uses dynamic parameters (5) of the vessel, including mass (m), the axial moments of inertia of the vessel, the mass distribution of the vessel, and hull parameters that determine the geometry of the hull.

11. The method of claim 1, in which the disconnection of said sensor signals (7) from said sensors (8) to said control system (2) is done by means of a switch (15a) on said signal line (12).

12. The method of claim 1, in which the disconnection of said command signals (8) from said command input device (10) to said control system (2) is done by means of a switch (15b) on said signal line (11).

13. The method of claim 1, in which said remote test laboratory (40) is located on land, and where said vessel (4a, 4b, 4c, ...) that is being tested is situated at a long distance from said test laboratory (40), typically between 1 and 20000 km, and where the vessel that is tested is in a harbor, in a dock or a yard, moored, or at the open sea.

14. The method of claim 1, in which failure situations are tested by disconnection one or more of selected signals at the time of said sensor signals (7) or said command signals (9) to simulate breakdown of components, and where the response of the control system in the form of said control signals (13, 13') and status signals (19, 19') are logged on a logger (15) in said remote test laboratory (40).

15. The method of claim 1, in which failure situations are tested by changing or generating disturbances in a selection of said simulated sensor signals (7'), or by generating external disturbances like weather, wind, electrical noise to said simulated sensor signals (7') that are sent from said remote test laboratory (40) to said control system (2) in said vessel (4), and where the response of said control system (2) in the form of said control signals (13, 13') and said status signals (19, 19') are logged on said logger (15) in said remote test laboratory (40).

16. The method of claim 1, in which new software for said control system (2) on board said vessel (4) is sent from said remote test laboratory (40) over said communication line (6).

17. The method of claim 1, in which said remote test laboratory (40) on basis of a test of said control system (2) and the test result, is used to approve said control system (2) and to certify said control system (2) for regular use in said vessel (4).

18. A system for testing a control system (2) in a vessel (4), said control system (2) being arranged to control and monitor said vessel (4), comprising the following features:

* one or more sensors (8) on board said vessel (4) to send one or more sensor signals (7) over a signal line (12) to said control system (2),
* command input devices (10) on board said vessel (4) arranged to send one or more of desired position, course, velocity (9) etc. over a command signal line (11) to said control system (2),
* an algorithm (31) in said control system (2) for the computation of control signals (13) to vessel actuators (3) on basis of said sensor signals (7), said command signals (9), for sending of said control signals (13) over a signal line (14) to said actuators (3), characterised by
* one or more communication lines (6) for sending of one or more simulated sensor signals (7') and/or simulated command signals (9') from a remote test laboratory (40) to said control system (2);

* a simulator (30) including an algorithm (32) for the simulation of new sensor signals (7') of a vessel model (4') based on the previous state (7, 7') said control signals (13, 13'), and dynamic parameters (5) for said vessel (4),
* in which said communication line (6) is arranged for sending back said new simulated sensor signals (7') of said vessel model (4') to said control system (2), for continued computation in said control system (2) on basis of the real and/or simulated values of said sensor signals (7, 7') or the real or simulated values of said command signals (9, 9'), of said control signals (13) to achieve at least one of said desired position, course, velocity (9) etc., and
* in which said communication line (6) is arranged for sending of the response from said control system (2) in the for of said control signals (13) as control signals (13') to said remote test laboratory (40).

19. The system of claim 18, comprising a switch (15a) is arranged to disconnect one or more of said sensor signals (7) from said signal line (12) to said control system (2).

20. The system of claim 18, comprising a second switch (15b) is arranged to disconnect one or more of said command signals (10) from said command signal line (11) to said control system (2).

21. The system of claim 18, comprising a third switch (15c) is arranged to disconnect one or more of said control signals (13) from said signal line (14) from said control system (2).

22. The system of claim 18, in which said dynamic parameters (5) of said vessel (4) enter into said algorithm (31) of said control system (2) for the computation of said control signals (13) to said actuators (3).

23. The system of claim 18, in which said remote test laboratory (40) is provided with a simulator (30).

24. The system of claim 18, in which said communication line (6) for sending of one or more of said simulated sensor signals (7') from said remote test laboratory (40) is arranged to be connected to and disconnected from a first real-time interface (6a), on said remote test laboratory (40).

25. The system of claim 18, in which said communication line (6) is arranged to be connected to and disconnected from a second real-time interface (6b) on said vessel (4), and where said second real-time interface (6b) is arranged to be connected to said signal line (11) to said control system (2) through said switch (15a).

26. The system of claim 18, comprising a simulated command input device (10') for sending of said simulated command signals (9') from said remote test laboratory (40) through said real-time interface (6a) and over said communication line (6) and through said real-time interface (6b) to said control system (2).

27. The system of claim 18, in which the entire of or parts of said algorithm (31) in said control system (2) is arranged to be modified, calibrated or replaced over said communication line (6) from said remote test laboratory (40).

28. The system of claim 18, in which said control signals (13) include signals (13a, 13b, 13c) in the form of shaft speed (13a, 13b) for one ore more propellers (16) or thrusters (17), and angles (13c) for rudders (18) or thrusters (17) or possibly other control devices.

29. The system of claim 18, wherein said sensors (8) include one or more of the following:

- position sensors (8a), to determine a position (7a), of said vessel (4) such as a GPS receiver (8a), hydroacoustic position sensors (8h), integrating acceleration sensors, etc.;
- course sensors (8b), to determine a course (7b) of said vessel (4), e.g. a gyrocompass or some other compass,
- a velocity sensor (8c) or an integrating acceleration sensor to determine a speed (7c)

of said vessel (4);

- an anemometer (8d, 8e) to give (relative) wind speed (7d) and wind direction (7e);
- a roll angle sensor (8f) to give a roll angle (7f);
- a pitch angle sensor (8g) to give a pitch angle (7g).

30. The system of claim 18, wherein said remote test laboratory (4) includes a data logger (15) for logging of the response in the form of said control signals and status signals (13', 19') from said control system (2) to said sensor signals (7, 7').